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Child and Adolescent Sleep Disturbances and Psychopathology in a Mental Health Clinic Sample

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ABSTRACT

Sleep disturbances in children and adolescents (hereafter children) are associated with significant short-term and long-term impairments including more severe psychopathology, reduced cognitive functioning, and poorer general health. We know that children being treated in specialty mental health services are more likely to have sleep disturbances than community samples. We also know that relationships exist between sleep and psychopathology in children with specific disorders (e.g. ADHD, depression, etc.). However, few studies have investigated the relationship between sleep and psychopathology in a broad sample of children seen at mental health agencies. Both child factors and family factors may influence both sleep and psychopathology. For example, family dysfunction and poor parenting practices have been associated with both increased sleep disturbances and psychopathology. This study aimed to examine individual child factors (e.g., age, sex, sensory sensitivity, pain) and family factors (e.g., family functioning, caregiver distress, lack of parenting strengths) along with sleep disturbances in relation to internalizing (e.g., depression, anxiety) and externalizing (e.g., attention-deficit/hyperactivity, conduct disorder) symptoms. The relationship between sleep and psychopathology may change as children move through developmental phases marked by structural and organizational changes in sleep-wake patterns and psychopathology prevalence. Thus, age was examined as moderator of the relationship between sleep and psychopathology.

KEYWORDS

Sleep, Children, Adolescents, Clinical Sample, Internalizing, Externalizing

SUMMARY FOR LAY AUDIENCES

Sleep disturbances in children and adolescents (hereafter children) are associated with significant difficulties in childhood and adulthood including poorer mental health, poorer intellectual abilities, and worse general health. We know there is a relationship between sleep and psychopathology in children with specific disorders (e.g. ADHD, depression). We also know that children being treated in specialty mental health services are more likely to have sleep disturbances than typical children in the community. However, few studies have looked at the relationship between sleep and psychopathology in a broad sample of children being treated at mental health agencies. Both individual child and family factors can influence both sleep and psychopathology. For example, family dysfunction and poor parenting practices may be related to worse sleep disturbances and psychopathology. In this study, we looked at child factors (e.g., age, sex, sensory sensitivity, pain) and family factors (e.g., family functioning, caregiver distress, lack of parenting strengths) along with sleep disturbances in relation to two categories of psychopathology, internalizing symptoms (e.g., depression, anxiety) and externalizing symptoms (e.g., attention-deficit/hyperactivity, conduct disorder). We also know that the relationship between sleep and psychopathology may change as children move through developmental phases marked by changes in sleep-wake patterns and psychopathology prevalence. Thus, we also considered how the relationship between sleep and psychopathology changes with age.

CO-AUTHORSHIP STATEMENT

This document and the related projects were completed under the supervision of Dr. Graham Reid.

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I would like to first thank my supervisor, Dr. Graham Reid, for the opportunity to learn from his expertise. I would also like to thank Dr. Shannon Stewart for her openness to collaboration and help in navigating the ChYMH database she established at Western.

I would like to thank my friends for their encouragement over the last two years. In particular Tyler, Maz, and Theresa, for their unique contributions to my sanity.

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Child and Adolescent Sleep Disturbances and Psychopathology

in a Mental Health Clinic Sample

Sleep disturbances in children and adolescents are associated with multiple short- and long-term impairments, such as reduced cognitive functioning, physical functioning, general health, and greater psychopathology (Alfano & Gamble, 2009; Chaput et al., 2016; Paruthi et al., 2016; Van Dyk, Thompson, & Nelson, 2016). Few studies have investigated sleep disturbances in a broad clinical sample of children and adolescents in mental health services, or considered how age and individual- or family-level factors might impact the relationship between sleep and psychopathology in a clinical mental health sample. Thus, the present study investigates the relationship between sleep and internalizing or externalizing problems in a clinical sample of children and adolescents age 5 to 18 years old, and the impact of individual factors, family factors and age as a moderator of these relationships. Understanding more about the relationship between sleep disturbances and psychopathology in children and adolescents can help in our understanding of early identification and symptom reduction strategies in vulnerable individuals.

SLEEP PROBLEMS AND MENTAL HEALTH

Sleep disturbances are experienced by 40% of children and adolescents in the community at some point in their development (Kahn et al., 1989; Mindell, Owens, & Carskadon, 1999). Studies that investigate sleep and internalizing or externalizing symptoms usually do so in typically developing children (Bagley & El-Sheikh, 2013). However, in a community sample of adolescents that met DSM-IV criteria for insomnia (i.e. difficulty initiating or maintaining sleep), 53% also met criteria for a comorbid psychiatric disorder (Johnson, Roth, Schultz, & Breslau,

2006). It is important that sleep difficulties are considered in children with mental health concerns due to increased prevalence and greater likelihood of complications.

The relationship between sleep problems and childhood psychiatric disorders is complex and considered bidirectional (Alfano & Gamble, 2009; Beebe, 2011; Gregory & O'Connor, 2002; Van Dyk et al., 2016). Childhood psychiatric disorders may cause or exacerbate sleep problems, sleep disturbances may interfere with emotion regulation and lead to mental health difficulties, or both may persist cyclically impairing a child's functioning in multiple domains across an extended period of time (Alfano & Gamble, 2009). When looking at the relationship between sleep and psychopathology in clinical samples, the majority of research focuses on specific diagnoses such as Autism Spectrum Disorder (ASD), Attention Deficit Hyperactivity Disorder (ADHD), and anxiety or depressive disorders (Alfano & Gamble, 2009; Alfano, Ginsburg, & Kingery, 2007; Benca, Obermeyer, Thisted, & Gillin, 1992; Gregory & Sadeh, 2012).

Sleep and Internalizing Problems

Internalizing problems are characterized by inner-directed emotions, negative affect, fear, and distress. This includes symptoms of disorders such as posttraumatic stress disorder (PTSD), Obsessive-Compulsive Disorder (OCD), anxiety, and depression (Blanco et al., 2015; Kotov et al., 2017). In a representative sample of adolescents in the general population, 90% of those who met DSM-III criteria for depression also reported at least one sleep disturbance such as insomnia or poor sleep quality (Reigstad, Jorgensen, Sund, & Wichstrom, 2010; Roberts, Lewinsohn, & Seeley, 1995). Among children and adolescents ages 6 to 17 with anxiety, 98% of those diagnosed with generalized anxiety disorder (GAD) and 97% diagnosed with social anxiety disorder (SAD) experienced at least one parent-reported sleep problem (e.g. insomnia) and

greater sleep problems were associated with greater anxiety severity (Alfano et al., 2007).

However, not all studies have found a significant relationship. A community study of children ages 7-12 found no relation between parent reported sleep problems and internalizing problems (Sadeh, Gruber, & Raviv, 2002).

There has been some concern that elevated reports of sleep disturbances in children and adolescents with anxiety or depression may be due to biases in self- or parent-report exaggerating symptoms. However, objective measures of sleep, such as actigraphy and electroencephalogram (EEG), have also found poor sleep (e.g. more night wakings) in children with anxiety and depression (Forbes et al., 2008).

Sleep and Externalizing Problems

Externalizing problems are characterized by outer-directed distress and undercontrolled behaviours. This includes symptoms of disorders such as oppositional defiant disorder (ODD), conduct disorder (CDD), substance use disorders (SUD), and ADHD (Achenbach, Howell, Quay, & Conners, 1991; Gregory & O'Connor, 2002; Kotov et al., 2017). Parent reports of community children ages 7-12 found that 'poor sleepers' were more likely to experience externalizing behaviours than 'good sleepers' (Sadeh et al., 2002). In clinical samples, it has been estimated that up to 50% of children ages 6 to 12 with ADHD experience sleep problems, such as difficulty with initiating or maintaining sleep; further, greater sleep problems have been related to more symptoms of inattention and hyperactivity (Corkum, Moldofsky, Hogg-Johnson, Humphries, & Tannock, 1999). A systematic review of reviews of sleep and ADHD in children and adolescents found that ADHD groups consistently had more parent-report sleep problems compared to normal control groups (Corkum & Coulombe, 2013).

Sleep in Mental Health Clinic Samples

Few studies have investigated sleep disturbances in broad clinical samples of children and adolescents in mental health services. Those that have suffer from important limitations and results across studies are contradictory. No study has included inpatients in their clinical sample although psychopathology tends to be more severe in these populations. No study has investigated how these relationships may differ between children and adolescents. In addition, no study has investigated the impact of individual- and family-level factors on the relationships between sleep and psychopathology in clinical samples of children. The impact of these risk factors will be discussed after a brief overview of relevant studies.

Simonds and Parraga (1984) investigated the frequency of sleep disturbances in 150 children and adolescents (ages 4-18) receiving outpatient mental health services compared to children in the general population. There were greater rates of sleep difficulties and health problems in the clinical sample compared to the general population. Among the clinical sample, restless sleep was most common in patients with DSM-III anxiety/affective disorders, conduct disorders, or attention deficit disorder (ADD). Patients with ADD experienced the greatest number of sleep difficulties. This study conceptualized sleep difficulties as being present at least once in the last 6 months; it is possible that individuals who were included in the analyses had sleep difficulties that abated or were very infrequent (Simonds & Parraga, 1984). The clinical sample in this study differed significantly from the general population in terms of age, medical health, and gender. This study also included individuals with significant cognitive deficits where sleep disturbances and psychopathology may be secondary to atypical development.

Ivanenko et al. (2006) investigated sleep complaints in 174 children (ages 5-18, mean age 10.5 ± 3.6) receiving care at an outpatient mental health clinic compared to a control group (ages 5-16, mean age 7.2 ± 2.2). Sleep was compared among children with ADHD alone, ADHD with comorbid mood and anxiety disorders, mood and anxiety disorders alone, and other psychiatric disorders. Children with a psychiatric disorder had greater sleep problems than non-psychiatric controls. Children with mood and anxiety disorders alone or ADHD comorbid with other psychopathology had more night awakening than ADHD alone or other psychiatric diagnoses, in contrast to Simonds and Parraga (1984) findings. Among children with psychiatric disorders, a strong correlation existed between sleep variables and internalizing and externalizing, except excessive daytime sleepiness which correlated with internalizing symptoms only (Ivanenko, Barnes, Crabtree, & Gozal, 2004; Ivanenko, Crabtree, Obrien, & Gozal, 2006). Although investigating a wide age range (ages 5 – 18), these studies did not include any analyses of age despite the impact on both sleep characteristics and type of psychopathology.

Reigstad et al. (2010) compared sleep in 129 adolescents (ages 13-17) receiving outpatient mental health services with adolescents in the community. Sleep disturbances (e.g., difficulty sleeping, feeling overtired) were experienced by 37% of community controls, compared to 80% of psychiatric outpatients. More sleep disturbances were associated with greater internalizing problems in both outpatients and the community. Further, only amongst the outpatients were sleep problems related to poorer family functioning (Reigstad et al., 2010). This study highlights the importance of considering family characteristics, such as family functioning, when assessing the relationship between sleep and psychopathology. However, this study only focused on adolescents and not younger children who may be differently impacted by psychopathology, sleep, and family variables.

RISK FACTORS FOR SLEEP PROBLEMS

There is a vast literature on risk and protective factors in the development of psychopathology (Grizenko & Fisher, 1992; Pinto et al., 2014; Rolf, Masten, Cicchetti, Nüchterlein, & Weintraub, 1990; Wille, Bettge, Ravens-Sieberer, & group, 2008). Numerous factors have been shown to contribute to both sleep and psychopathology at the individual- and family- level. At the individual level, problems with a child's processing of their surroundings (e.g. increased sensitivity to loud noises) or physical sensations may impact sleep and psychopathology. At the family level, increased daily or environmental stressors may also impact the child's sleep and psychopathology. Thus, one aim of the current study was to determine whether sleep disturbances impact psychopathology above and beyond the effects of these common factors. The current study is a secondary analysis of a dataset from children's mental health agencies across Ontario that includes inpatient and outpatient programs. As such, data existed for a limited number of potentially important risk and protective factors. Variables examined were selected from the available dataset based on their relevance to sleep and psychopathology. Relevance was determined based on a review of the theory and literature relating sleep and psychopathology with a focus on children and adolescents.

Individual-Level Factors

Child Age. It is understood that school-age children need more sleep than adolescents or adults (Meltzer & Mindell, 2006). Age has also been related to prevalence of sleep problems. A longitudinal study investigating sleep problems (e.g., "experiences nightmares", "sleeps less than most children", "sleeps more than most children", "talks or walks in sleep", "trouble sleeping", and "overtired") in a community sample found that overall sleep disturbances decreased from

age 4 to mid-adolescence (Gregory & O'Connor, 2002). Although sleep disturbances are highly prevalent among children with psychiatric disorders, it is unclear how age will affect the prevalence of sleep disturbances in a clinical sample of children and adolescents as this has not been investigated (Ivanenko & Johnson, 2008).

Age as a Moderator. The relationship between sleep and psychopathology may alter as children move through developmental phases marked by structural and organizational changes in sleep-wake patterns (Feinberg & Campbell, 2010). Specifically, age related changes have consistently been observed in the relationship between sleep disturbances and internalizing disorders such as depression and anxiety (Benca et al., 1992; Johnson, Chilcoat, & Breslau, 2000). The strength of the association between sleep problems and internalizing symptoms increased from age 4 ($r = 0.39$) into mid-adolescence ($r = 0.52$). Similarly, sleep problems (e.g., insufficient sleep, poor sleep quality) had a weaker influence on symptoms of depression ($r = 0.39$) and anxiety ($r = 0.39$) for children age 8, than for children ages 10 to 13 years old; depression ($r = 0.54$) and anxiety ($r = 0.46$) (Kelly & El-Sheikh, 2014). A meta-analysis by Lovato and Gradisar (2014) further demonstrated that overall the association between sleep disturbances and depression was greater in adolescents than children (Lovato & Gradisar, 2014).

In contrast, the relationship between sleep disturbances and externalizing disorders does not seem to alter with age. A longitudinal study of children age 4 to mid-adolescence found that there was no significant age-related change in the correlation between sleep and aggression (age 4, $r = 0.45$; mid-adolescence, $r = 0.40$; average correlation across the 11-years, $r = 0.38$) or sleep and attention problems (age 4, $r = 0.38$; mid-adolescence $r = 0.46$; average correlation across the 11-years, $r = 0.37$; Gregory & O'Connor, 2002). These results suggest that although the

relationship between sleep problems and internalizing disorders is moderated by age, the relationship between sleep problems and externalizing disorders is not.

Pain. Higher levels of pain intensity are associated with poorer sleep quality and depressive symptoms in both community samples and clinical samples of children with chronic pain (Siu, Chan, Wong, & Wong, 2012). Longer sleep duration and greater time awake after sleep onset have also been associated with greater pain the following day (Lewandowski, Palermo, De la Motte, & Fu, 2010). Compared to adolescents with sleep disturbances only, adolescents with both chronic pain and sleep disturbances had poorer subjective sleep quality, greater sleep disturbances, more daytime dysfunction, and greater depressive symptoms (Siu et al., 2012). Thus, in the present study, pain will be considered as a secondary variable contributing to both symptoms of psychopathology and sleep disturbances.

Sensory Processing. In healthy children, tactile sensitivity has been related to greater sleep disturbances (e.g., bedtime resistance, night waking) and both tactile sensitivity and sensation seeking have been related to greater behavioural problems (e.g., impulsiveness, distractibility, restlessness, mood swings, frustration, and social difficulty; Shochat, Tzischinsky, & Engel-Yeger, 2009). Sensation seeking refers to behaviours such as creating noise for noises sake or seeking movement (e.g. rocking back and forth) that interferes with daily routine. Tactile sensitivity refers to behaviours such as reacting emotionally or sensitively to touch or experiencing distress during grooming (Tomchek & Dunn, 2007). Studies examining children suggest that atypical sensory behaviours, such as tactile sensitivity, are associated with lower sleep quality in both children with and without autism (Foitzik & Brown, 2018; Reynolds, Lane, & Thacker, 2012; Shochat et al., 2009). Thus, in the present study, measures of increased

sensory sensitivity will be considered as a secondary variable contributing to both symptoms of psychopathology and sleep disturbances.

Family-Level Factors

Family Stressors. Parent and family stressors, such as family dysfunction and parental psychological difficulties, have been associated with sleep disturbances and psychopathology in children (Lavigne et al., 1999; Reigstad et al., 2010; Seifer, Sameroff, Dickstein, Hayden, & Schiller, 1996). Several studies using structural equation modeling have found higher family stressors lead to more sleep disturbances, in turn contributing to greater behavioural problems (Bates, Viken, Alexander, Beyers, & Stockton, 2002; El-Sheikh, Buckhalt, Mark Cummings, & Keller, 2007; Goodnight, Bates, Staples, Pettit, & Dodge, 2007; Reid, Hong, & Wade, 2009). Family disorganization and maternal depression are also correlated with more sleep disturbances in preschool aged children (Gregory & O'Connor, 2002). Thus, in the present study, family stressors will be considered a secondary variable contributing to both symptoms of psychopathology and sleep disturbances.

Positive Parenting. Several studies have found that positive parenting is related to positive outcomes in children, including increased sleep duration (Philips, Sioen, Michels, Sleddens, & De Henauw, 2014; Sadeh, Tikotzky, & Scher, 2010). Specific parental variables such as parental warmth and emotional security have also been related to increased total sleep time among school-aged children (Adam, Snell, & Pendry, 2007; El-Sheikh et al., 2007). Positive parenting refers to behaviours that improve the relationship between parents and their children, such as communication, warmth, support, and supervision. In the present study, a lack

of positive parenting will be considered as a secondary variable contributing to both symptoms of psychopathology and sleep disturbances

CURRENT STUDY

It is important to look at the relationship between sleep and psychopathology as the cumulative effects of these difficulties can have short-term and long-term impacts on the wellbeing of children and adolescents. While psychopathology can be complex and difficult to treat, treatment for sleep difficulties are relatively straightforward, easy to implement, and can result in significant benefits among children and adolescents experiencing difficulties with internalizing and externalizing behaviours.

Hypotheses. This study will examine the impact of individual differences, family factors, and sleep disturbances on psychopathology in a clinical sample of children age 4 to 18 from children's mental health clinics Canada. It is hypothesized that:

- 1) Children with greater sleep disturbances will have higher levels of internalizing and externalizing problems. The relationship between sleep and internalising or externalizing problems is expected to hold after controlling for common factors.
- 2) Age will moderate the relationship between sleep disturbances and internalizing disorders; the relationship between sleep disturbances and internalizing disorders will be greater with age. However, age is not expected to moderate the relationship between sleep disturbances and externalizing disorders.

- 3) The following individual child variables are expected to relate to greater sleep disturbances and higher levels of psychopathology: (a) greater pain frequency and (b) sensory sensitivity.
- 4) The following family variables are expected to relate to greater sleep disturbances and higher levels of psychopathology: (a) greater family distress, and (b) lower levels of positive parenting.

METHODS

The present study involves secondary data analyses of administrative data from children's mental health agencies in Ontario. This approach allowed for a selection of specific individual and family level variables that are meaningful to both sleep and psychopathology across a large clinical sample of children and adolescents. The overall dataset is described below followed by details regarding the sample and measures for the present study.

InterRAI Child and Youth Mental Health (ChYMH) Sample

This study conducted secondary data analyses of interRAI ChYMH information collected between 2012 and 2018, which represented the entire span of the dataset available at the time this study was conducted. This dataset consisted of cross sectional data. In cases where multiple records existed for unique IDs, initial appointments were kept and later appointments were removed from the dataset. A total of 14,384 children from 4 to 18 years old and their families completed the ChYMH assessment as part of standard care in residential or outpatient settings across 39 mental health agencies in Ontario, Canada. Each child received a unique Case Record Number (CRN) to identify ChYMH records within an agency. Although this dataset did not

include duplicate CRNs, it is possible that an individual was double counted if they completed a ChYMH at multiple agencies and the CRN was not carried over. The ChYMH is a comprehensive assessment intended to create an overall picture of areas of strengths and weaknesses. Symptoms are assessed using a combination of parent and child report, with greater emphasis on self-report as children increase in age (discussed in greater detail below; Stewart et al., 2015).

As part of an ongoing data sharing agreement, data from all agencies using the ChYMH are stored in an anonymized interRAI database intended for research purposes, that includes no identifying information for the children or their families. Data from this research database are stored at the University of Western Ontario on secure computers maintained by Dr. S. Stewart. Given the nature of how this dataset is collected from agencies, no information is available on the percentage of clients at each agency who did not complete the ChYMH assessment.

Current Study Sample

Figure 1 presents the inclusion criteria, exclusion criteria and total cases included in analyses. Study criteria included selection based on clinical/demographic characters and availability of relevant measures. In the current study, children were excluded if it was determined that they had an intellectual or learning disability ($IQ < 79$, $N = 298$) because of the high prevalence of sleep problems in this population and a potential relationship to disordered sleep mechanisms (Quine, 1991; Stores, 1992). Children were also excluded if they fell outside of the intended age 4 – 18 year range of the ChYMH comprehensive assessment ($N = 146$).

For primary measures considered essential for the current study, cases were removed if they were missing one of sleep, internalizing, or externalizing, as these measures are the focus of the analyses ($N = 246$). Predictor variables were considered secondary measures; cases were removed if they were missing parenting strengths as it was possible to have missing data for this question if it did not apply (e.g., no parent or guardian, emancipated youth). For other secondary measures, cases were excluded if two or more measures were missing from family functioning, caregiver distress, or pain. A measure was considered missing if more than 15% of the individual items were missing.

Overall, 222 cases were excluded due to missing secondary measures, either missing the parenting strengths measure or missing two of the family functioning, parenting strengths, or pain measures. Initial versions of the ChYMH did not include questions about sensory sensitivity, thus multiple imputation analysis was conducted in SPSS to account for this non-random missing information ($N = 859$). Cases with and without sensory sensitivity were compared on other study variables to ensure there were no significant differences. A total of 13,472 children were included in the analyses with an average age 12.1 years ($SD = 3.4$); 56% were male.

A split-sample approach was used to control for error and determine whether results are reproducible. In analyses where significance is found in only one sample, results will not be considered robust findings; as such, only findings that were statistically significant in both split-samples are reviewed. The sample was broken down into two groups based on a random selection of approximately 50% of cases, Sample 1 ($n = 6773$) and Sample 2 ($n = 6699$).

Measures

InterRAI Child and Youth Mental Health (ChYMH) Assessment

The interRAI ChYMH is a semi-structured assessment tool designed to assist with care planning, connection to services, and outcome tracking. It consists of 400 items that assess areas of risk, child strengths and weaknesses, medical issues, and family dynamics (Stewart et al., 2015). The ChYMH uses a combination of various sources such as self-report, parent-report, teacher-report, medical records, and clinical observation where appropriate to complete the ChYMH. All clinicians administering the ChYMH undergo standardized training and must pass an online test. The ChYMH assessment is conducted by a trained clinician with the assistance of an interpretation guide that outlines question intent, definitions of key terms, time frame under consideration, and specific scoring systems (Stewart et al., 2015). Typically, symptoms are assessed for their frequency in the past 3 days (72 hours), although there is some variability when indicated. For example, the presence of stressful life events, such as death or loss of a parent or primary caregiver, are assessed in intervals of the last 3 days, 4 – 7 days ago, 8 – 30 days ago, 31 days – 1 year ago, more than 1 year ago, or never.

The ChYMH has a total of 23 official measures that are typically scored by summation of relevant items. Although a paper version of the ChYMH is available, data are most often entered using a software-based system where measures are automatically scored based on pre-set rules. Measures above a predetermined threshold are highlighted as possible areas of strength or risk, and collaborative action plans (CAPs) provide recommendations for additional action by clinicians (Lau, Stewart, Saklofske, & Hirdes, 2019; Stewart et al., 2015).

ChYMH Measures: Present study

The present study examines individual and family level factors using official and research-based ChYMH measures and individual items. In the present study, ChYMH measures were conceptualized as either subscales or indices as described below. Descriptive statistics and average scores across items for variables used in the present study are reported in Table 1.

Scales/subscales are reflective markers of an underlying construct. A greater presence of scale items indicates greater observable effects of a latent variable, thus we would expect these items to co-occur and have reasonable Cronbach's α .

Indices are causal indicators of an underlying construct. Although more index items contribute to a greater presence of a latent variable, we would not necessarily expect index items to co-occur so cannot make definitive statement about within-construct correlations (Bollen & Lennox, 1991; Diamantopoulos & Winklhofer, 2001). Only the subscales and indices used in the present study are described in detail below.

All subscales and indices were calculated using an average across items that were present with allowance for up to 15% of missing items before being considered missing. If one of the primary measures (sleep, internalizing, externalizing), parenting strengths, or two of the secondary measures (family functioning, caregiver distress, pain) were considered missing the individual record was removed from analyses.

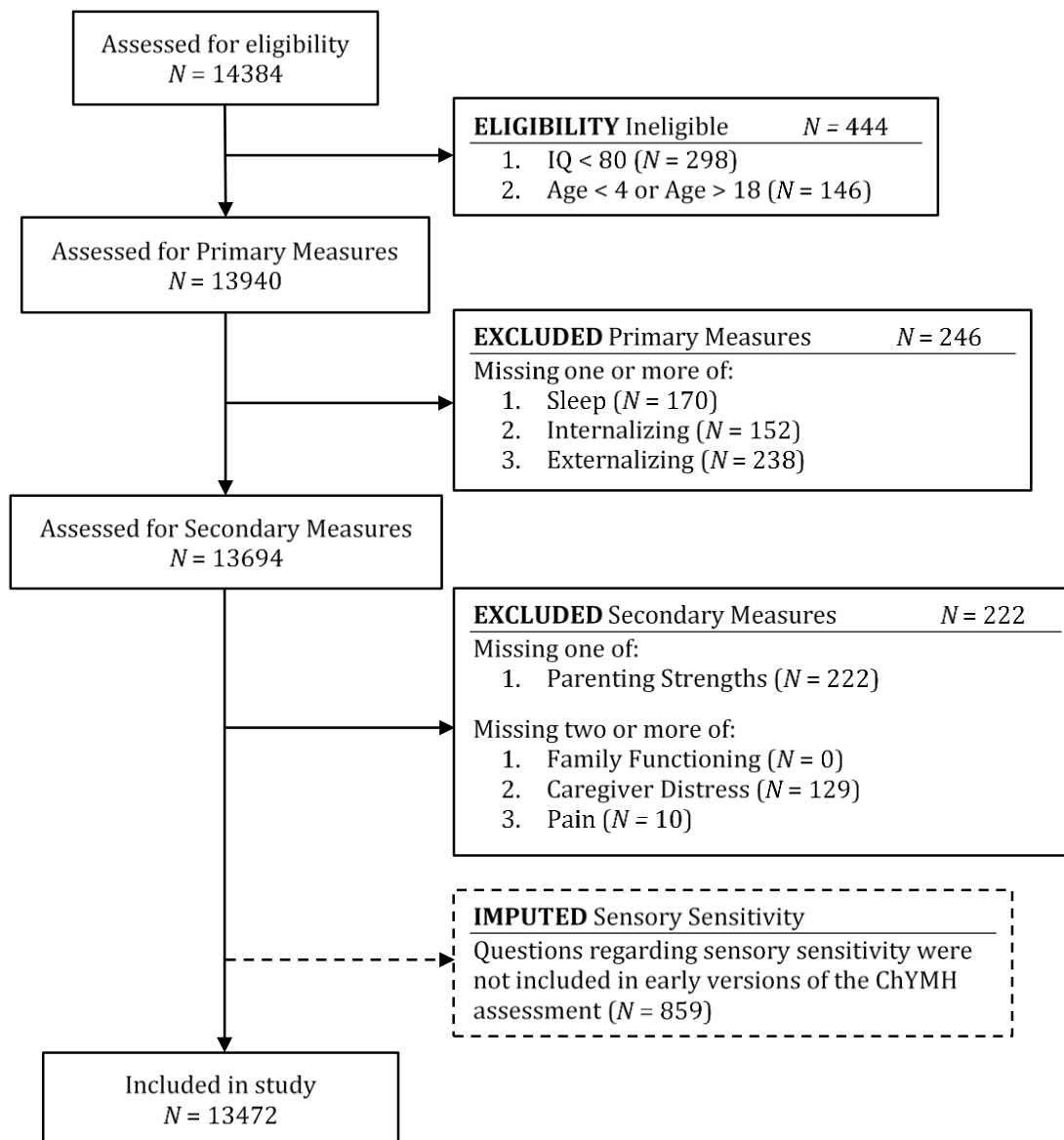


Figure 1. Cases Included in Analyses

Table 1
Means and Standard Deviations for Sample 1 and Sample 2

| Variables | Sample 1 – All | | | Sample 2 – All | | | Sample 1 – Adolescent | | | Sample 2 – Adolescent | | |
|--|----------------|----------|-----------|----------------|----------|-----------|-----------------------|----------|-----------|-----------------------|----------|-----------|
| | <i>N</i> | <i>M</i> | <i>SD</i> | <i>N</i> | <i>M</i> | <i>SD</i> | <i>N</i> | <i>M</i> | <i>SD</i> | <i>N</i> | <i>M</i> | <i>SD</i> |
| 1. Internalizing | 6773 | .85 | .73 | 6699 | .86 | .74 | 3773 | .98 | .78 | 3600 | .98 | .79 |
| 2. Externalizing | 6773 | .38 | .26 | 6699 | .38 | .26 | 3773 | .34 | .27 | 3600 | .34 | .27 |
| 3. Sex ^a | | | | | | | | | | | | |
| a. Male | 3817 | 56.4% | | 3745 | 55.9% | | 1748 | 46.3% | | 1625 | 45.1% | |
| b. Female | 2941 | 43.4% | | 2938 | 43.9% | | 2010 | 53.3% | | 1960 | 54.4% | |
| 4. Age ^b | 6773 | 12.19 | 3.56 | 6699 | 12.10 | 3.57 | 3773 | 14.88 | 1.74 | 3600 | 14.92 | 1.72 |
| 5. Pain | 6769 | .24 | .63 | 6696 | .22 | .60 | 3769 | .31 | .72 | 3597 | .28 | .68 |
| 6. Parenting Strengths ^c | 6773 | 1.72 | .44 | 6699 | 1.72 | .45 | 3773 | 1.64 | .49 | 3600 | 1.63 | .51 |
| 7. Caregiver Distress | 6760 | .23 | .23 | 6688 | .23 | .22 | 3760 | .24 | .23 | 3590 | .23 | .23 |
| 8. Family Functioning ^d | 6773 | .26 | .25 | 6699 | .25 | .25 | 3773 | .28 | .27 | 3600 | .28 | .27 |
| 9. Sensory Sensitivity ^e | 6773 | .43 | .83 | 6699 | .43 | .83 | 3773 | .27 | .67 | 3600 | .28 | .69 |
| 10. Sleep | 6773 | .86 | .88 | 6699 | .84 | .88 | 3773 | .88 | .90 | 3600 | .86 | .89 |
| 11. Adolescent - Subjective Sleep ^f | | – | – | | – | – | 3449 | 1.69 | .90 | 3298 | 1.70 | .91 |

Note. Data were randomly assigned to Sample 1 or Sample 2.

Note. Scores shown represent an average across scale or index items. Average scores are out of the following: Internalizing (0 to 4), Externalizing (0 to 1), Pain (0 to 3.5), Parenting Strengths (0 to 2), Caregiver Distress (0 to 1), Family Functioning (0 to 1), Sensory Sensitivity (0 to 4), Sleep (0 to 4), Adolescent - Subjective Sleep (0 to 3).

^a Sex was coded as follows: 1 = male, 2 = female, 3 = other.

^b Age was calculated as year of assessment minus year of birth.

^c Higher scores reflect lower levels of parenting strengths.

^d Higher scores reflect lower levels of family functioning.

^e If original value was missing, used average across all 5 imputations.

^f Variable only included in adolescent supplement for children ages 12 and older.

Outcomes

Internalizing and Externalizing Scales

The ***Internalizing Scale (Int)*** was developed through further research of ChYMH items (Lau et al., 2019). The Internalizing scale consists of 3 subscales: anxiety, anhedonia, and depression. Each subscale is composed of 4 items: anxiety (repetitive anxious complaints/concerns, hypervigilance, unrealistic fears, episodes of Panic), anhedonia (lack of motivation, anhedonia, withdrawal from activities of interest, decreased energy), and depression (made negative comments, self-deprecation, expressions of shame or guilt, expressions of hopelessness). Each item is scored from 0 to 4 based on presence over the last 3 days (*0 = not present; 1 = present but not exhibited in last 3 days; 2 = exhibited on 1–2 of last 3 days; 3 = exhibited daily in last 3 days, 1-2 episodes; 4 = exhibited daily in last 3 days, 3 or more episodes or continuously*). For a final Int score, the average score across items were computed; scores range from 0 to 4 with greater scores indicating greater levels of internalizing symptoms (Lau et al., 2019). Internal consistency for the Int scale in this study was good: Cronbach's $\alpha = .85$.

The ***Externalizing Scale (Ext)*** was also developed through further research of ChYMH items (Lau et al., 2019). The Externalizing scale consists of 12 items that assess under-controlled and outer-directed manifestations of symptoms. Under controlled-symptoms consists of 5 items that assess: verbal abuse, anger outbursts or intense flare-ups in reaction to a specific event, symptoms of impulsivity, defiant behaviour, and argumentativeness. Outer-directed symptoms consists of 7 items that assess: stealing, threats/attempts to elope, bullying peers, preoccupation with violence, violence to others, intimidation or threatened violence to others, and violent ideation. The 5 under-controlled items are coded based on presence in the last 3 days (*0 = not*

present; 1 = present but not exhibited in last 3 days; 2 = exhibited on 1– 2 of last 3 days; 3 = exhibited daily in last 3 days, 1-2 episodes; 4 = exhibited daily in last 3 days, 3 or more episodes or continuously). The 7 outer-directed items are scored according to a 5-point scaling system (*0 = never, 1 = more than 1 year ago, 2 = 31 days to 1 year ago, 3 = 8 to 30 days ago, 4 = 4 to 7 days ago, 5 = in the last 3 days*). All scores are then dichotomized: 0 = item absent (score of 0); 1 = item present (score of 1 to 4, score of 1 to 5). For a final Ext score all 12 items are averaged; scores range from 0 to 1 with greater scores indicating higher levels of externalizing symptoms (Lau et al., 2019). Internal consistency for the Ext scale was good: Cronbach's $\alpha = .86$.

Predictor Variables

Demographics

Child birth year and sex (male, female, other) are recorded at the time of the ChYMH assessment. Age is calculated based on birth year and year of the assessment.

Sleep Disturbances

The *Sleep Disturbances (Sleep)* measure is comprised of 4-items: (a) difficulty falling asleep or staying asleep (e.g. waking up too early or restlessness), (b) waking up multiple times at night, (c) falling asleep during the day (not including nap time), and (d) resisting bedtime (e.g. not wanting to sleep at appropriate time or difficulty sleeping without caregiver intervention). Informants are asked about the frequency of specific sleep problems over the last 3 days (*0 = not present; 1 = present but not exhibited in last 3 days; 2 = exhibited on 1– 2 of last 3 days; 3 = exhibited daily in last 3 days, 1-2 episodes; 4 = exhibited daily in last 3 days, 3 or more episodes or continuously*). Scores for Sleep range from 0 to 16, the average score across items

ranges from 0 to 4 with higher scores indicating a greater degree of sleep difficulty. The sleep measure is best conceptualized as an index as the individual items contribute to sleep disturbances as a whole, and may not necessarily co-occur. As such, internal consistency for the sleep items was not computed.

The *Adolescent Supplement - Sleep* is a single sleep item that is part of a set of additional questions completed by all children over 12. Younger children may complete this form if they engage in behaviours considered more prevalent in adolescence (e.g., having a child, drug abuse). Adolescents are asked how they would rate their general sleep quality (*0 = excellent, 1 = good, 2 = fair, 3 = poor*), scores range from 0 to 3 with higher scores indicating poorer subjective sleep. Previous research has shown that parents tend to idealize adolescent sleep, and that adolescent self-report of sleep disturbances are more severe and more in line with objective measures of sleep disturbance, such as actigraphy (Short, Gradisar, Lack, Wright, & Chatburn, 2013).

Family Disturbances

The *Caregiver Distress (CD)* measure consists of 5-items that assess stress and trauma experienced by parents or primary caregivers (hereafter caregivers). Items are scored as either present (1) or absent (0) and include: (a) major life stressors for caregivers in the last 90 days (e.g., severe illness, death or severe illness of close family member/friend, loss of home, major loss of income/assets, victim of crime or robbery, persistent unemployment); (b) limited funds in the last 30 days resulting in caregiver or emancipated youth making trade-offs purchasing adequate food, shelter, clothing, prescribed medication, sufficient home heating/cooling, or necessary health care; (c) caregiver unable or unwilling to continue in caring activities; (d)

caregiver expresses feelings of distress, anger, or depression; and (e) current developmental or mental health issues in parents/primary caregiver. The total CD score was the average across all 5 items; scores range from 0 to 1 with higher scores indicating greater caregiver distress. The CD items are best conceptualized as an index rather than a scale; as such, internal consistency was not computed.

The ***Family Functioning (FF)*** measure consists of 6-items that measures different aspects of family functioning based on the presence (1) or absence (0) of: (a) family that are persistently hostile or critical of child/ youth; (b) family reporting feeling overwhelmed by child/youth's condition; (c) caregiver with current developmental or mental health issue; (d) sibling with current developmental or mental health issues; (e) caregiver unable or unwilling to continue in caring activities; and (f) a strong and supportive relationship with family.. For the current study, a FF score was computed by summing only four of the six items. The two outstanding items appear on both the FF and CD measures, so were removed from FF to avoid double counting. Based on Spearman correlations, these two items (i.e., primary caregiver unable or unwilling to continue care activities; primary caregiver with developmental, mental health, or substance use issues) had greater item-total correlations with remaining items in the CD measure ($r = .23$ and $.29$) than the FF measure ($r = .23$ and $.25$). The total score for the described FF was the average across all items; scores range from 0 to 1 with higher scores indicating greater family dysfunction. The FF items are best conceptualized as an index rather than a scale; as such, internal consistency was not computed.

The ***Parenting Strengths (PS)*** scale consists of 6-items that have been reverse coded to assess the *lack* of parenting strengths. Items are rated on the frequency of interaction between

caregiver and child/youth, taking into account developmental age of the child (*0 = most of the time, 1 = occasionally, 2 = rarely or never*). The interactions between caregiver and youth/child include: (a) effective communication, (b) assistance with emotion regulation, (c) appropriate discipline, (d) warmth and support demonstrated, (e) supervision and monitoring as appropriate, and (f) appropriate expectation or limit setting. Total PS scores was the average across all items; scores range from 0 to 2 with higher scores indicating lower parenting strengths. Internal consistency for the PS scale in this study was good: Cronbach's $\alpha = .89$.

Individual Differences

The ***Pain (Pain)*** measure consists of 2 items: (a) frequency of pain and (b) intensity of pain. The frequency is captured by how often the child/youth shows evidence of or complains of pain (*0 = none, 1 = present but not exhibited in last 3 days, 2 = exhibited on 1 - 2 of last 3 days, 3 = exhibited daily in the last 3 days*). The intensity of the highest level of pain present in the specified time period is scored (*0 = no pain, 1 = mild, 2 = moderate, 3 = severe, 4 = times when pain is horrible or excruciating*). A total Pain score was computed by averaging score across the 2 items; scores range from 0 to 3.5 with higher scores indicating higher pain severity.

The ***Sensory Sensitivity (SS)*** measure is derived from a Sensory Difficulty measure in the ChYMH that includes 5 items related to both gross and fine motor skills and excessive responses to stimuli in general (i.e., excessive or unusual reaction to sensory stimuli, sensory seeking behaviour, sensory avoiding behaviour). Since there is no evidence for gross or fine motor skills impairment impacting sleep, the current study assesses sensory sensitivity using only the 3 items that measure responses to stimuli. The total described SS measure was the average across all items; scores range from 0 to 4 with higher scores indicating greater sensory sensitivity. The SS

items are best conceptualized as an index rather than a scale; as such, internal consistency was not computed.

DATA ANALYSIS

Sample Size/Power

The total sample size is 13,472 individuals in the deidentified research database that completed the ChYMH and meet inclusion (age) and exclusion (intellectual disability) criteria. Individual cases were removed if they were missing one primary measure, parenting strengths, or any two secondary measures needed for analyses. Sensory sensitivity was imputed when missing due to early version of the ChYMH not including these items. Given the size of the smallest split-half sample ($N = 3600$ for adolescent sample 2), we would be able to detect an effect size of $r = .05$ with 90% power and $\alpha = .05$ (using G*Power. Version 3.1.9.3; Faul, Erdfelder, Lang, & Buchner, 2007).

Hierarchical Regressions

Four hierarchical regression analyses were conducted: (1) internalizing for all ages, (2) internalizing for adolescents only, (3) externalizing for all ages, (4) externalizing for adolescents only. Hierarchical regressions were performed using each dataset of imputed sensory sensitivity values separately prior to being combined into a single value (Rubin, 1987).

Variables were entered in 5 blocks. For the first step, demographic variables (sex, age) were entered. In the second step, family variables (parenting strengths, caregiver distress, family functioning) were entered. In the third step, individual variables (pain, sensory sensitivity) were

entered. In the fourth step, sleep disturbances were entered. Significant findings here suggest that changes in sleep disturbances are related to symptoms of psychopathology because they represent the effect of the predictor variable (internalizing or externalizing symptoms) on sleep disturbances after accounting for other variables.

The fifth step differed if analyses were conducted for all ages or for adolescents only. For all ages, the fifth step included the interaction term (sleep x age) to determine whether age moderated the relationship between sleep and symptoms of psychopathology. Sleep disturbances and age were mean centered prior to computing the interaction term (Kreft, de Leeuw, & Aiken, 1995). For adolescents only, the fifth step included adolescent report of subjective sleep quality to determine whether self-perception of sleep quality had an additional relationship to symptoms of psychopathology above and beyond reported sleep disturbances. When a significant age x sleep interaction was found the relationship was examined after controlling for other factors and mean centering variables of interest using the Preacher and Hayes PROCESS Macro for SPSS (Hayes, 2013). Graphs of the sleep X age effects were plotted with using -1 SD, Average, and +1SD values of age.

RESULTS

Descriptive Statistics

For both Sample 1 and Sample 2, the means and standard deviations were calculated for demographics, primary measures, and secondary measures (see Table 1). All reported scores represent an average score of items included in the specified scale or index. The distributions of the outcome variables were examined; both were positive skewed and not normally distributed.

For average internalizing scores, analyses revealed a skewness of 1.10 ($SE = 0.02$) and a kurtosis of 0.95 ($SE = 0.04$). For average externalizing scores, analyses revealed a skewness of 0.22 ($SE = 0.02$) and a kurtosis of -0.80 ($SE = 0.04$). However, these values are below the levels deemed to be problematic (Kline, 2016).

Correlations

Correlations of variables for Sample 1 (below the diagonal) and Sample 2 (above the diagonal) are reported (see Table 2). For the majority of cases, correlations were significant in both Sample 1 and Sample 2. Absolute values of r were interpreted as weak (.10 to .29), moderate (.30 to .49), and strong (.50 and above; Cohen, 1988).

As would be expected, ChYMH sleep scores and adolescent subjective sleep ratings had a moderate to strong correlation. Among demographic variables, internalizing symptoms had weak positive correlations with sex and age. Conversely, externalizing symptoms had weak negative correlations with sex and age.

As expected, internalizing symptoms were moderately correlated with sleep scores and adolescent subjective sleep. A weak correlation was found between sleep and externalizing symptoms, although the relationship between externalizing symptoms and adolescent subjective sleep was not significant.

Overall, correlations for secondary predictor variables (family functioning, caregiver distress, parenting strengths, sensory sensitivity) were higher for externalizing symptoms than for internalizing symptoms. However, the relationship between pain and externalizing symptoms was not significant.

Hierarchical Regressions

Hierarchical multiple regression analyses were used to determine the predictive power of sleep disturbances on internalizing symptoms or externalizing symptoms after accounting for individual- and family-level variables. Overall, four hierarchical regressions were conducted: (1) internalizing for all ages, (2) internalizing for adolescents only, (3) externalizing for all ages, (4) externalizing for adolescents only. Analyses involving self-report sleep were conducted for adolescents only as this variable was not available for younger children. The incremental contribution (i.e., percentage of variance accounted for) to psychopathology for each block was examined. Beta values from the final regression equation (block 5) are reported for internalizing symptoms (Table 3) and externalizing symptoms (Table 4).

In the full sample (all ages), block hierarchical regression showed that demographics, family variables, individual variables, sleep difficulties, and age as a moderator explained a significant amount of the variance in internalizing symptoms (Sample 1 $R^2 = .269$, Sample 2 $R^2 = .285$) and externalizing symptoms (Sample 1 $R^2 = .281$, Sample 2 $R^2 = .289$).

The variable subjective sleep was only available for a subset of individuals who completed the adolescent supplement to the ChYMH. Among adolescents, block hierarchical regression found that demographics, family variables, individual variables, sleep difficulties, and subjective sleep explained a significant amount of the variance in internalizing symptoms (Sample 1 $R^2 = .239$, Sample 2 $R^2 = .276$) and externalizing symptoms (Sample 1 $R^2 = .271$, Sample 2 $R^2 = .288$).

Table 2

Correlations Among Sample 1 Variables (below diagonal) and Among Sample 2 Variables (above diagonal)

| Variables | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|--|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|
| 1. Internalizing | | .150** | .156** | .228** | .190** | -.095** | .203** | .218** | .175** | .419** | .309** |
| 2. Externalizing | .130** | | -.230** | -.180** | .020 | -.284** | .315** | .383** | .232** | .218** | .008 |
| 3. Sex ^a | .165** | -.244** | | .240** | .090** | -.044** | .000 | .003 | -.121** | .058** | .140** |
| 4. Age ^b | .247** | -.195** | .231** | | .115** | -.236** | .023 | .137** | -.227** | .028* | .144** |
| 5. Pain | .180** | .011 | .097** | .136** | | -.049** | .109** | .061** | .051** | .166** | .143** |
| 6. Parenting Strengths ^c | -.105** | -.192** | -.075** | -.212** | -.068** | | -.307** | -.489** | .097** | -.108** | -.101** |
| 7. Caregiver Distress | .208** | .294** | .007 | .025* | .110** | -.343** | | .461** | .109** | .205** | .120** |
| 8. Family Functioning ^d | .224** | .367** | .035** | .132** | .100** | -.477** | .472** | | | .203** | .110** |
| 9. Sensory Sensitivity ^e | .153** | .199** | -.126** | -.236** | .045** | .069** | .089** | .061** | | .172** | .006 |
| 10. Sleep | .393** | .224** | .034** | .035** | .145** | -.117** | .235** | .228** | .169** | | .503** |
| 11. Adolescent - Subjective Sleep ^f | .304** | .014 | .112** | .173** | .127** | -.117** | .133** | .153** | .048** | .495** | |

Note. * $p \leq 0.5$, ** $p \leq .01$.

Note. Data were randomly assigned to Sample 1 (below diagonal) or Sample 2 (above diagonal). Due to tolerance of missing values in secondary measures and a subset of adolescent only data, N 's vary across correlations. For Sample 1 data, N 's are as follows: for all ages variables $N = 6760 - 6773$; for adolescent subjective sleep $N = 3449$. For Sample 2 data, N 's are as follows: for all ages variables $N = 6688 - 6699$; for adolescent subjective sleep $N = 3298$.

^a Sex was coded as follows: 1 = male, 2 = female, 3 = other.

^b Age was calculated as year of assessment minus year of birth.

^c Higher scores reflect lower levels of parenting strengths.

^d Higher scores reflect lower levels of family functioning.

^e If data was missing, reported value is the average across 5 imputations.

^f This variable was only included in the adolescent supplement for children ages 12 and older.

Table 3
Hierarchical Multiple Regression: Internalizing Symptoms

| Variable | Sample 1 – All | Sample 2 – All | Sample 1 – Adolescent | Sample 2 – Adolescent |
|--|-------------------|-------------------|--------------------------|--------------------------|
| | β | β | β | β |
| <i>Step 1: Demographics</i> | | | | |
| Sex ^a | .111*** | .096*** | .162*** | .158*** |
| Age ^b | .234*** | .221*** | .084*** | .079*** |
| ΔR^2 by Block 1 | .073 | .062 | .054 | .047 |
| F by Block 1 | 267.458*** | 221.021*** | 97.836*** | 81.350*** |
| <i>Step 2: Family Variables</i> | | | | |
| Parenting Strengths ^c | .055*** | .060*** | .030 | .051** |
| Caregiver Distress | .086*** | .078*** | .070*** | .047** |
| Family Functioning ^d | .087*** | .098*** | .080*** | .093*** |
| ΔR^2 by Block 2 | .058 | .057 | .051 | .043 |
| F by Block 2 | 202.809*** | 179.691*** | 80.825*** | 64.560*** |
| <i>Step 3: Individual Variables</i> | | | | |
| Pain | .066*** | .076*** | .066*** | .090*** |
| Sensory Sensitivity ^e | .153*** | .159*** | .109*** | .132*** |
| ΔR^2 by Block 3 | .049 | .058 | .036 | .055 |
| F by Block 3 | 211.050*** | 204.674*** | 80.531*** | 79.490*** |
| <i>Step 4: Sleep Difficulties</i> | | | | |
| Sleep | .310*** | .335*** | .268*** | .331*** |
| ΔR^2 by Block 4 | .086 | .102 | .090 | .126 |
| F by Block 4 | 305.991*** | 323.062*** | 128.480*** | 152.047 |
| <i>Step 5: Age as a Moderator</i> | | | | |
| Sleep x Age | .057*** | .076*** | - | - |
| ΔR^2 by Block 5 | .003 | .006 | - | - |
| F by Block 5 | 276.395*** | 295.376*** | - | - |
| <i>Step 5: Subjective Sleep</i> | | | | |
| Adolescent Subjective Sleep ^f | - | - | .107*** | .085*** |
| ΔR^2 by Block 5 | - | - | .008 | .005 |
| F by Block 5 | - | - | 119.660*** | 138.682*** |

Note. * $p \leq 0.5$, ** $p \leq .01$, *** $p \leq .001$.

Note. β values reported for model 5 only.

^a Sex was coded as follows: 1 = male, 2 = female, 3 = other.

^b Age was calculated as year of assessment minus year of birth.

^c Higher scores reflect lower levels of parenting strengths.

^d Higher scores reflect lower levels of family functioning.

^e Analyses were conducted using values from 5 imputations and the average value reported.

^f Variable only included in adolescent supplement for children ages 12 and older.

Table 4
Hierarchical Multiple Regression: Externalizing Symptoms

| Variable | Sample 1 – All | Sample 2 – All | Sample 1 – Adolescent | Sample 2 – Adolescent |
|--|-------------------|-------------------|--------------------------|--------------------------|
| | β | β | β | β |
| <i>Step 1: Demographics</i> | | | | |
| Sex ^a | -.183*** | -.185*** | -.217*** | -.211*** |
| Age ^b | -.209*** | -.165*** | -.143*** | -.103*** |
| ΔR^2 by Block 1 | .079 | .070 | .067 | .068 |
| F by Block 1 | 290.799*** | 251.520*** | 123.641*** | 120.681*** |
| <i>Step 2: Family Variables</i> | | | | |
| Parenting Strengths ^c | -.069*** | -.048*** | -.099*** | -.057*** |
| Caregiver Distress | .105*** | .133*** | .088*** | .135*** |
| Family Functioning ^d | .284*** | .289*** | .283*** | .295*** |
| ΔR^2 by Block 2 | .177 | .187 | .180 | .193 |
| F by Block 2 | 464.609*** | 462.079*** | 225.524*** | 231.714*** |
| <i>Step 3: Individual Variables</i> | | | | |
| Pain | -.010 | -.005 | .006 | .012 |
| Sensory Sensitivity ^e | .086*** | .122*** | .075*** | .096*** |
| ΔR^2 by Block 3 | .010 | .019 | .009 | .013 |
| F by Block 3 | 350.013*** | 363.081*** | 168.494*** | 177.012*** |
| <i>Step 4: Sleep Difficulties</i> | | | | |
| Sleep | .127*** | .121*** | .145*** | .041*** |
| ΔR^2 by Block 4 | .015 | .013 | .010 | .010 |
| F by Block 4 | 328.989*** | 338.928*** | 155.454*** | 162.596*** |
| <i>Step 5: Age as a Moderator</i> | | | | |
| Sleep x Age | -.006 | -.005 | - | - |
| ΔR^2 by Block 5 | .000 | .000 | - | - |
| F by Block 5 | 292.445*** | 301.256*** | - | - |
| <i>Step 5: Subjective Sleep</i> | | | | |
| Adolescent Subjective Sleep ^f | - | - | -.079*** | -.076*** |
| ΔR^2 by Block 5 | - | - | .004 | .004 |
| F by Block 5 | - | - | 141.361*** | 147.464*** |

Note. * $p \leq 0.5$, ** $p \leq .01$, *** $p \leq .001$.

Note. β values reported for model 5 only.

^a Sex was coded as follows: 1 = male, 2 = female, 3 = other.

^b Age was calculated as year of assessment minus year of birth.

^c Higher scores reflect lower levels of parenting strengths.

^d Higher scores reflect lower levels of family functioning.

^e Analyses were conducted using values from 5 imputations and the average value reported.

^f Variable only included in adolescent supplement for children ages 12 and older.

Results from hierarchical regression suggest there was a stronger relationship between sleep and internalizing symptoms than sleep and externalizing symptoms after accounting for demographics, individual-, and family-level factors. For internalizing symptoms in the full sample (all ages), sleep difficulties explained an additional 10% of variance in symptoms after controlling for demographics, individual, and family variables. Age as a moderator (sleep x age) and adolescent subjective sleep added very little additional variance.

The demographics, individual-, and family-level variables accounted for a significant amount of variance in internalizing scores ($F(9, 13431) = 560.09, p < .001$), with an R^2 of .27. The addition of the sleep x age interaction term was significant ($\beta = .0435, p < .01$) with a ΔR^2 of .004. Figure 2 shows that the relationship between sleep disturbances, internalizing symptoms, and age. For externalizing, a similar interaction term was insignificant making results difficult to interpret.

For externalizing scores in the full sample (all ages), family variables explained an additional 19% of variance after accounting for demographics. Parenting strengths were significant and negatively related to higher externalizing scores, whereas family functioning and caregiver distress positively related. Sleep difficulties, although significant, only added an additional 1% of variance, and sleep as a moderator (sleep x age) or adolescent subjective sleep did not add variance. Note, that although statistically significant, the direction of the relationship between adolescent subjective sleep and externalize in the regression (Table 4) is opposite to the bivariate correlation (Table 2). This change in sign represents a suppressor effect; as such it is not appropriate to interpret this relationship (Maasen & Bakker, 2001; Tzelgov & Henik, 1991).

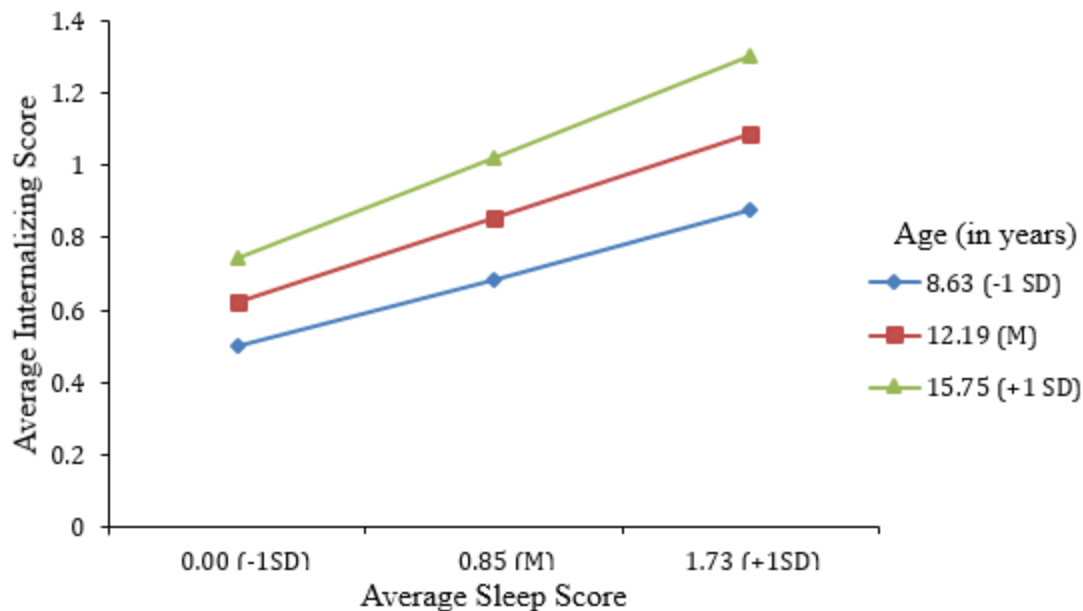


Figure 2. Relationship Between Internalizing and Sleep by Age

DISCUSSION

The results of these analyses support the importance of considering the impact of sleep difficulties in clinical samples of children and adolescents, with particular focus on the importance of sleep and internalizing disorders among adolescents.

Sleep Disturbances and Psychopathology

Analyses found that sleep disturbances had a significant relationship to psychopathology for both internalizing ($\Delta R^2 = 10\%$) and externalizing ($\Delta R^2 = 1\%$) problems, above and beyond other individual and family variables. This greater relationship between sleep and internalizing symptoms compared to externalizing symptoms in children is in line with previous research (Bagley & El-Sheikh, 2013; Quach, Nguyen, Williams, & Sciberras, 2018).

Treatments targeting sleep disturbances are often inexpensive and easy to implement, and may reduce both sleep disturbances and psychopathology. A randomized controlled trial of internet and group-based cognitive behavioural therapy for insomnia (CBT-I) found, in adolescents with insomnia and psychopathology, targeted intervention to improve insomnia resulted in lasting improvements to both insomnia and mental health symptoms, such as depression (de Bruin, Bögels, Oort, & Meijer, 2018). As this population is already undergoing intake assessments at mental health agencies, it would be simple to provide online sleep resources for outpatients or to integrate sleep interventions (e.g., relaxation training, sleep education, stimulus control, mindfulness) into inpatient programs as part of care at these agencies.

Sleep and Internalizing Symptoms

Sleep contributed a sizeable percentage of variance in internalizing, but not externalizing, difficulties suggesting that sleep should receive specific attention in treatment for children with internalizing difficulties, such as anxiety or depression. Monitoring of sleep in children and adolescents with internalizing problems could provide insight into fluctuations in mental health. Research has shown that specific sleep disturbances in children and adolescents with major depressive disorder, such as sleep efficiency and sleep latency, predict recurrence of depression within 1 year for inpatients and outpatients (Emslie et al., 2001). Longitudinal studies of children age 4 to 13 support the notion that increased sleep difficulties in childhood contributed to increased internalizing difficulties in adolescence (Quach et al., 2018). This highlights the importance of considering sleep difficulties when addressing internalizing difficulties.

Sleep and Externalizing Symptoms

Although significant, the relationship between sleep and externalizing difficulties, after accounting for individual- and family-level variables, was low. There have been mixed findings in regards to the relationship between sleep and externalizing difficulties in children and adolescents. Research has found a relationship between sleep and specific externalizing difficulties, namely ADHD and ODD, after controlling for comorbidity with GAD, depression, and other externalizing disorders. It is possible that the relationship between sleep and specific externalizing problems, like ADHD and ODD, is driven by the shared feature of significant irritability (Shanahan, Copeland, Angold, Bondy, & Costello, 2014).

Age as a Moderator

Consistent with our hypothesis, age moderated the relationship between sleep and internalizing but not externalizing difficulties. Although significant, the impact of the interaction term (sleep x age) was small (Table 3, Figure 2). Longitudinal research looking at the reciprocal relationship of sleep difficulties and anxiety and depression has found that the influence of sleep difficulties on internalizing problems, such as depression and anxiety, may be stronger during early adolescence (ages 10 to 13) as compared to childhood (ages 8 to 10). This change in reciprocal relationships could in part be due to interactions changing across developmental periods or difficulties during critical periods in development (Kelly & El-Sheikh, 2014).

Although specific mechanisms have not been well established, studies of varying modalities suggest an important role for biological, psychological, and social mechanisms underlying the relationship between insomnia and internalizing disorders in adolescence. A review of mechanisms underlying the relationship between insomnia, anxiety, and depression in adolescence found that among biological mechanisms, puberty and sleep deprivation may have

an additive effect on reward processing, specifically increasing vulnerability to internalizing disorders among those experiencing sleep difficulties during adolescence (Blake, Trinder, & Allen, 2018). Psychological research has shown that among adolescents (age 11 to 19) with a sleep disorder, 87% reported catastrophic thinking prior to sleep largely focused around interpersonal relationships at school and school performance (Hiller, Lovato, Gradisar, Oliver, & Slater, 2014). As social pressures increase for adolescents entering high school, increased catastrophic thinking might contribute to both sleep and internalizing difficulties in this age group. Poor sleep might undermine behavioural and emotional regulation in adolescents and reduce their resources for coping in social and family situations. These limited coping mechanisms might be overwhelmed in adolescents experiencing high family stress and low socioeconomic status, thus disrupting interpersonal relationships and increasing risk for anxiety and depression (Blake et al., 2018).

Family Variables

Lack of parenting strengths, increased family stressors, and caregiver distress were all significantly associated with internalizing, externalizing, and sleep difficulties (Table 2). This is in line with previous research that suggests parent and family stressors, such as family dysfunction and parental psychological difficulties, are associated with sleep disturbances and psychopathology in children (Lavigne et al., 1999; Reigstad et al., 2010; Seifer et al., 1996). A meta-analytic review of protective and risk factors for sleep in adolescents (ages 12 to 18) found that specific sleep difficulties, namely sleep latency, worsened as a negative family environment increased (Bartel, Gradisar, & Williamson, 2015).

Hierarchical regression analyses found that family variables significantly contributed to psychopathology above and beyond demographic variables for both internalizing difficulties ($\Delta R^2 = 6\%$; Table 4) and externalizing difficulties ($\Delta R^2 = 19\%$; Table 5). The larger role of family variables in externalizing as compared to internalizing difficulties is in line with previous research. A review of risk and protective factors in children and adolescents (age 0 to 18) with emotional and behavioural disorders found that a nonsupportive home environment and corporal punishment by parents were moderately correlated ($r = .41$) with externalizing disorders. However, negative parenting style was only weakly correlated ($r = .16$) with internalizing disorders (Crews et al., 2007). It is possible that these family variables are reflective of other difficulties, such as poverty or domestic violence, which could be further impacting measures of psychopathology.

Individual Variables

Pain

Pain was significantly associated with sleep and internalizing, but not externalizing, difficulties (Table 2). Previous research has found that, compared to adolescents with sleep disturbances only, adolescents with both chronic pain and sleep disturbances had poorer subjective sleep quality, greater sleep disturbances, more daytime dysfunction, and greater depressive symptoms (Siu et al., 2012).

Sensory Sensitivity

Sensory sensitivity was significantly associated with sleep, internalizing, and externalizing difficulties (Table 2). This is in line with previous research that has shown that

tactile sensitivity has been associated with greater sleep disturbances (e.g., bedtime resistance, night waking) and greater behavioural problems (e.g., impulsiveness, distractibility, restlessness, mood swings, frustration, and social difficulty) in healthy children (Shochat et al., 2009).

Adolescent Self -Report Sleep

There is some concern that sleep problems may be underestimated by parent-report, especially when it comes to severity. An epidemiological study found that, among children age 8 to 9, although 287 children reported trouble sleeping every night, parents only reported severe sleep difficulties for 17 children. This suggests that over 95% of severe sleep problems were reported only by children themselves and not by their parents (Paavonen et al., 2002). Another study of youth age 7 to 12 found that parents seemed unaware of child sleep difficulties that could be related to behavioural disturbances such as daytime fatigue (Aronen, Paavonen, Fjällberg, Soininen, & Törrönen, 2000). One study among adolescents age 13 to 17 found that there were significant differences among the percentage that met criteria for a sleep problem (66.6%), self-reported a sleep problem (21.1%), or had parents who reported their adolescent had a sleep problem (14.3%; Short, Gradisar, Gill, & Camfferman, 2013). As children age, parents are less aware of sleep disturbances due to reduced involvement in bedtime routines and reduced daytime monitoring. Because of this, it was hypothesized that adolescent self-report of sleep quality could be meaningful above and beyond the sleep difficulties measure.

Although significant, adolescent self-report sleep had a weak relationship to both internalizing and externalizing symptoms above and beyond ChYMH sleep scores. This could be in part due to the nature of the ChYMH as a collaborative assessment. Unlike typical studies of parent- and child- report measures, the ChYMH is a collaborative tool and standard ChYMH

items may include information from multiple sources, such as parents, children, teachers, or medical documents. Although a child's ability to contribute to the assessment is minimal at a young age, it is possible that adolescents are more likely to have their perspective incorporated into general ChYMH assessment item scores.

LIMITATIONS

This study could be improved by adding a measure of objective sleep, such as actigraphy bands worn by participants. Subjective reports of sleep disturbance are common in mental health, but do not necessarily align with objective measures of sleep disturbance. For example, in a review of subjective and objective sleep measures in children and adolescents with mental health disorders, when compared to health controls *children* with anxiety who report sleep disturbances do not objectively have abnormal sleep although *adolescents* with anxiety and self-report sleep disturbances do show objective measures of sleep disturbance, such as high sleep onset latency and high sleep duration (Alfano, Patriquin, & De Los Reyes, 2015; Baddam, Canapari, van Noordt, & Crowley, 2018; Mullin et al., 2017). In children and adolescents with ADHD, both groups show differences in subjective and objective measures of sleep disturbance compared to healthy controls and this relationship did not change with age (Baddam et al., 2018). It is possible that subjective and objective measures of sleep disturbance in a broad clinical sample of children and adolescents will have different relationships to individual (e.g, sensory sensitivity, pain) and family level variables (e.g., family functioning, care giver distress) across age and internalizing or externalizing symptoms.

Despite the benefits of using a clinical sample, other diagnoses could have impacted our measures, such as chronic medical conditions, obesity, or physical sleep disorders such as

obstructive sleep apnea. In addition, the clinical nature of this sample means that children and adolescents may have been receiving medications, which could affect the relationship between sleep and psychopathology or impact sleep and psychopathology symptoms at different rates.

A unique Case Record Number (CRN) is used to identify ChYMH records within an agency. This allows multiple administrations of the ChYMH to be compared across time, and helps maintain anonymity within the larger ChYMH database. For this dataset, only the initial ChYMH record was examined. Records were sorted by CRN and date, and any records after the initial assessment were removed to avoid an individual being represented multiple times. However, if an individual completed a ChYMH at multiple agencies, it is possible a new CRN was assigned resulting in overrepresentation.

Results were reported as the average of items used in a scale or index to allow for missing data and to assist with interpretation across items. In addition, several ChYMH measures were adapted for the purpose of these analyses to remove duplicated or unrelated items. As such, direct comparisons of the results from this study to previous research using the ChYMH cannot be made. Although it is clear when results are elevated, there are no guidelines for when an elevated score would warrant intervention for sleep issues.

FUTURE RESEARCH

The present study conducted analyses on average scores of multiple items in indices or scales. Future research could investigate the relationship between sleep and psychopathology for specific sleep deficits or specific mental health symptoms from scales or indices instead of using composite scores. For example, some research suggests that negative family environment impacts sleep latency more than other sleep difficulties (Bartel et al., 2015). Other research suggests that a common factor to internalizing and externalizing disorders, such as irritability or

emotion dysregulation, could be driving the relationship between sleep and specific difficulties such as depression, anxiety, attention, hyperactivity, or oppositional behaviour (Bagley & El-Sheikh, 2013; Shanahan et al., 2014).

Future research could also examine standalone variables in the ChYMH dataset (i.e. variables that are not part of scales or indices) for their relevance to sleep difficulties and psychopathology. For example, primary nocturnal enuresis (bedwetting) is included in the ChYMH assessment and is considered a risk factor for sleep disturbances (Esposito et al., 2013). Research suggests that rates of nocturnal enuresis in children age 7 to 17 are higher among those with anxiety disorders such as generalized anxiety disorders, panic disorder, or social anxiety compared to healthy children (Salehi, Yousefichaijan, Rafeei, & Mostajeran, 2016). In addition, research suggests that parenting plays a unique role in the development of enuresis above and beyond psychopathology, such as anxiety or ADHD (Kessel et al., 2017).

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